

D.C. MOTOR AND WINDING METHOD FOR COILS THEREOF

Background of the Invention

1. Field of the Invention

The present invention relates to a D.C. motor and a winding method for coils of the D.C. motor, wherein the stator coils of the motor can be conveniently wound to thereby construct a stator of a D.C. motor.

2. Description of the Related Art

Fig. 7 of the drawings illustrates a conventional D.C. motor stator 90 formed by a radial winding method. In the winding method for the stator 90, an end of a conducting wire 901 forms a first connection V_1 before the winding procedure. When the conducting wire 901 has been wound around a half number of the pole arms, i.e., pole arms 90a and 90b of the stator 90, the winding procedure is halted for pulling out the conducting wire 901 to form a second connection V_0 (the common connection). Then, the winding procedure continues for the remaining of the pole arms (i.e., pole arms 90c and 90d). After the winding procedure is finished, the other end of the conducting wire 901 forms a third connection V_2 . The stator 90 may use a dual-coil motor driver to generate alternating rotational magnetic fields to thereby drive the rotor having magnetic poles N and S. Nevertheless, the winding procedure must be interrupted for formation of the second connection V_0 .

Fig. 8 illustrates a stator 91 using another conventional radial winding method. An end of a conducting wire 911 forms a first connection V_1 before winding around the stator 91. After the winding procedure is finished, the other end of the conducting wire 911 forms a second connection V_2 . The stator 91 may use a single-coil motor driver and supplies the single coil with alternating electric current to

1 generate alternating rotational magnetic fields to thereby drive the
2 rotor having magnetic poles N and S. Nevertheless, in this method
3 using a single conducting wire 911 for carrying out winding, the
4 conducting wire 911 must be wound around each pole arm 91a, 91b,
5 91c, 91d for as many turns as the required turns of the coil. The
6 winding time for the stator 91 cannot be reduced, as the winding speed
7 is limited.

8 Applicant U.S. Patent Application No. 09/610,970 filed on July
9 6, 2001 and entitled C BRUSHLESS MOTOR HAVING RADIAL
10 WINDING AND RADIAL AIR GAP AND METHOD FOR
11 CARRYING OUT THE RADIAL WINDING as illustrated in Fig. 9
12 of the drawings of the present application, comprises a stator 92
13 having a number of pole arms 92a, 92b, 92c, and 92d around which
14 two conductive wires 921 and 922 are wound. Each conducting wire
15 921, 922 needs to be wound for just a half of turns to finish winding
16 of the stator 92 with required turns. After formation of the winding on
17 the stator 92, it can then be decided the number (two or three) of the
18 connections to be connected with the drive circuit.

19 Each conducting wire of each of these brushless motors having
20 a radial winding and a radial air gap is wound around each pole arm
21 of the stator. The winding procedure is difficult and the winding speed
22 is largely limited, as the gap between the pole arms is small. In
23 addition, an insulating layer deposited on an outer periphery of the
24 conducting wire tends to be damaged by the pole arms during the
25 winding procedure, which results in a short circuit of the coils.

26 Fig. 10 of the drawings, which corresponds to Fig. 4 of U.S.
27 Patent No. 4,922,162 to Shiraki et al. issued on May 1, 1990 and
28 entitled ISK-TYPE SINGLE-PHASE BRUSHLESS MOTOR,
29 discloses a stator for a brushless motor having an axial gap. The coils

1 931 and 932 are firstly wound for the required turns and then bonded
2 by tapes or bonding agents to the stator yokes 93a and 93b on a circuit
3 board 93. Each coil 931, 932 has terminals 931a and 931b, 932a and
4 932b passing through V-shaped notches in the circuit board 93. The
5 terminal 931a, 931b, 932a, 932b are soldered to a printed conductor
6 pattern formed on a lower face of the printed circuit board 20 so as to
7 establish electric connection therebetween. The coils of such a
8 conventional brushless motor having an axial air gap require careful
9 soldering so as to avoid wrong connection although they can be wound
10 easily.

11 **Summary of the Invention**

12 It is an object of the present invention to provide a method for
13 carrying out winding of a D.C. motor in which winding of the stator
14 coils can be easily achieved and damage to the coils by the pole plates
15 of the stator during the winding procedure can be avoided.

16 It is another object of the present invention to provide a D.C
17 brushless motor having stator coils that can be easily fixed for easy
18 processing and assembly.

19 A winding method in accordance with the present invention
20 comprises winding a single conducting wire around a predetermined
21 number of pegs in sequence to thereby form a stator coil assembly
22 having even coils and two ends. The winding direction of each coil is
23 opposite to a coil adjacent thereto. The stator coil assembly having
24 even coils is mounted to a casing of a D.C. motor with the coils
25 located corresponding to a permanent magnet of a rotor. The rotor
26 having the permanent magnet is driven to turn by magnetic forces
27 created as a result of energizing the coils.

28 Other objects, specific advantages, and novel features of the
29 invention will become more apparent from the following detailed

description and preferable embodiments when taken in conjunction with the accompanying drawings.

Brief Description of the Drawings

Fig. 1 is a perspective view illustrating a first step of a winding method in accordance with the present invention.

Fig. 2 is a side view illustrating a second step of the winding method in accordance with the present invention.

Fig. 3 is a side view illustrating a third step of the winding method in accordance with the present invention.

Fig. 4 is an exploded perspective view of a brushless motor having a radial air gap and using the method in accordance with the present invention.

Fig. 5 is a sectional view of the brushless motor in Fig. 4.

Fig. 6 is an exploded perspective view of a brushless motor having an axial air gap and using the method in accordance with the present invention.

Fig. 7 is a sectional view of a conventional brushless motor having a radial air gap.

Fig. 8 is a sectional view of another conventional brushless motor having a radial air gap.

Fig. 9 is a sectional view of a further conventional brushless motor having a radial air gap.

Fig. 10 is a plan view of a coreless stator armature of a conventional brushless motor having an axial air gap.

Detailed Description of the Preferred Embodiments

Preferred embodiments in accordance with the present invention will now be described with reference to the accompanying drawings.

Figs. 1 and 2 illustrate a winding method for a stator coil assembly 10 in accordance with the present invention.

1 The stator coil assembly 10 in accordance with the present
2 invention is formed by means of winding a single conducting wire 1
3 around a number of pegs 2 having predetermined shapes in sequence
4 and in the same direction (clockwise in Figs. 1 and 2). The total
5 number of the coils of the stator coil assembly 10 is selected according
6 to the number of poles of the motor to be formed. The turns of each of
7 the even coils 10a, 10b, 10c, and 10d are identical to each other and
8 selected according to need. Thus, the even coils 10a, 10b, 10c, and 10d
9 of the stator coil assembly 10 are formed by means of continuously
10 winding a conducting wire 1 having a first end 11 and a second end
11 12.

12 Referring to Fig. 3, after formation of the stator coil assembly
13 10 with even coils 10a, 10b, 10c, and 10d by a single, continuous
14 winding procedure, each of the odd-numbered coils (i.e., coil 10a, 10c)
15 or each of the even-numbered coils (i.e., coil 10b, 10d) is turned
16 through 180°. In this preferred embodiment, the even-numbered coils
17 10b and 10d (counting from the left side of the drawings) are turned
18 through 180°. Thus, the winding direction of the even-numbered coils
19 10b and 10d becomes opposite to that of the odd-numbered coils 10a
20 and 10c. In this preferred embodiment, the winding direction of the
21 even-numbered coils 10b and 10d is counterclockwise while the
22 winding direction of the odd-numbered coils 10a and 10c is clockwise.
23 Thus, changing in the direction of the electric current of the coils 10b
24 and 10d and in the direction the resultant magnetic field is allowed by
25 means of changing the winding direction of the coils 10b and 10d.

26 Figs. 4 and 5 illustrate a motor having a radial air gap and using
27 the winding method in accordance with the present invention. The
28 motor comprises a casing 3 having a chamber 31. A support section 32
29 is provided in a bottom of the chamber 31 for rotatably supporting a

shaft 41 of a rotor 4. The rotor 4 comprises a permanent ring magnetic 42 having north and south poles. The casing 4 further comprises plural mounting members 33 on an outer wall face or an inner wall face thereof. Each mounting member 33 may be a countersink or a peg for mounting and retaining a respective coil 10a, 10b, 10c, 10d of the stator coil assembly 10. In addition, the coils 10a, 10b, 10c, and 10d are located corresponding to the permanent ring magnet 42 of the rotor 4. Since the direction of the electric current and the direction of the magnetic field of each coil 10a, 10b, 10c, 10d are opposite to those of the coil adjacent thereto, alternating magnetic fields are created when the stator coil assembly 10 is supplied with electric current. The resultant magnetic force may repulse the permanent ring magnet 42 of the rotor 4 to turn. In addition, an IC control means 34 comprised of a Hall element and a drive circuit and provided on the casing 3 detects a change in the polarity of the permanent ring magnet 42 of the rotor 4 and sends a signal to alternately change the direction of each coil 10a, 10b, 10c, 10d, thereby keeping the rotor 4 turning.

Fig. 6 illustrates a motor having an axial air gap and using the winding method in accordance with the present invention. The motor comprises a casing 3 having a chamber 31 for rotatably holding a shaft 41 of a rotor 4. The rotor 4 comprises a disc (not labeled) on a top thereof. A permanent magnetic 43 is mounted to the disc and has north and south poles. A stator yoke 35 and a circuit board 36 are mounted in a bottom of the chamber 31. An IC control means 34 comprised of a Hall element and a drive circuit is provided on the circuit board 36. The stator yoke 35 is provided with two coils 10a and 10b wound by a single conducting wire in accordance with the present invention, wherein the coils 10a and 10b are wound in opposite directions and thus have opposite electric current directions and opposite magnetic

1 field directions. The permanent magnet 43 of the rotor 4 is driven to
2 turn by magnetic repulsive forces created by means of energizing the
3 coils 10a and 10b.

4 According to the above description, it is appreciated that the
5 D.C. motor stator and the winding method in accordance with the
6 present invention allow easy processing and manufacturing. The short
7 circuit problem of the coils resulting from damage of the coils by the
8 pole plates during the winding procedure is avoided. In addition, the
9 stator assembly having even coils is formed by means of continuously
10 winding a single conducting wire in sequence. Thus, the stator coil
11 assembly has only a first end and a second end, thereby allowing easy
12 electric connection or assembly without the risk of incorrect
13 connection.

14 Although the invention has been explained in relation to its
15 preferred embodiment as mentioned above, it is to be understood that
16 many other possible modifications and variations can be made without
17 departing from the scope of the invention. It is, therefore,
18 contemplated that the appended claims will cover such modifications
19 and variations that fall within the true scope of the invention.
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